

Interactive comment on “Accumulation and modeling of particles in drinking water pipe fittings” by K. Neilands et al.

Anonymous Referee #2

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General aspects =====

In general this is an important topic. This work is a piece in a big cake to understand the fouling of drinking water distribution systems and resulting water quality impairments. In the current situation, however, the paper is not biggest piece (that one with the cherry). ;-)

Due to the complexity of modelling particulate fouling in the black box distribution system it should be considered that all aspects influencing the deposit formation for the experiments described in this paper are critically discussed.

It should be noted that strong changes in the turbidity pattern of a pipe flushing may have also other important reasons beside the presence of pipe fittings. The most

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important one is that deposits are non-uniformly distributed within the network. If, for instance, two pipes with very different geometries or hydraulic conditions are connected with each other and are cleaned in a single flushing step, strong variation may occur around the pipe connection. Additionally, strong gradients in the distribution of deposits over the pipe length may be observed for pipes daily operated with low flow velocities. Potentially, deposit peaks due to fittings (especially T-pieces at pipe connections or crosses) and general deposit formation behaviour may overlap respectively superpose.

The POODS approach itself (as far as I know from Boxall & Saul, 2005) is an empirical (let's say phenomenological) modelling approach to predict the mobilization of deposits. Therefore, the deposits have to be in a steady state, as far as I know. For me it sounds as if in the paper from Boxall, Skipworth and Saul (2001) (which I've not read!) additional equations are presented compared to the paper from 2005 named above, describing the the deposit formation. Is this correct?

In the equation I understood, there where simple mistakes I list below. Please self-check the bigger empirical equations (3b, 6), which I could not prove.

Details =====

p. 140, L. 21: Rayan et al., 2008 → Ryan et al., 2008

p. 144, L. 9: The standard deviation for measurements was ± 30 s → What does that mean? (I don't understand this.)

p. 145, L. 23: Remark: This is an application of the time-distance law.

p. 145, L. 25: Equation wrong. Should be $V = q * t$, $V = \pi/4 * D^2 * L \rightarrow Q * t = \pi/4 * D^2 * L \rightarrow L = 4 * Q * t / (\pi * D^2)$ with $t=0$ at start of flushing

p. 146, L. 13: "[...] The is a large number [...]" → There is a large number ...

p. 146, L. 17: Suggestion: The stability of deposit layers is, according to the POODS model, based on the hydraulically induced shear of the bulk water on the deposit sur-

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faces. The maximum (daily) occurring hydraulic wall shear stress is equivalent to the minimal shear stability of deposits.

p. 146, L. 23: Equation wrong: If this shall be the equation for the wall shear (which is the maximum shear stress occurring in a pipe cross section in N/m^2) the correct formula is $\tau_w = \rho \cdot g \cdot D/4 \cdot I$ with the hydraulic radius $D/4$ in metres and the dimensionless energy gradient I . This energy gradient is $I = h_f / L$ with the head loss h_f in metres as well as the pipe length L . The head loss is calculated with the Darcy-Weisbach equation $h_f = f \cdot L/D \cdot v^2/(2 \cdot g)$.

p. 148, L. 15: "[...] The layers can have higher stored turbidity volume [...]" → Weak layers (according to shear stability) can store more turbidity units than strong layers.

p. 149, L. 9: I don't understand the equation. if it is the objective to calculate the particle mass with eq. (7), the unit of the TSS should be $NTU/(kg/m^3)$, so $Turb \cdot TSS$ yields kg/m^3 as unit. TSS should then be the correlation parameter of a (linear) relationship between turbidity and TSS (e.g. $Turb = TSS \cdot TS$; $TS = \text{total solids in } kg/m^3$). For the determination of the parameter TSS a wide range of samples have to be analyzed for TS and turbidity as stated correctly in line 13, p. 149.

p. 151, L. 4: "[...] namely the increase of the particle concentration towards the mains dead ends. [...]" → the amount of deposits does not compulsorily increase at the end of pipe mains. If there are no suspended particles transported to the end of a pipe, which may settle, then there is also no deposit formation.

p. 151, L. 14: "[...] which predicts that the particles on pipe walls are conditioned by the shear stress [...]" → more accurate: " which predicts that the particulate deposits on pipe walls are conditioned by the shear stress"

p. 152, L. 15: What are the reasons for the introduction of the empirical relationship V/D ? Is there a polynomial fit?

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